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Evaluation of Steinmann pin and Intramedullary interlocking nail on physiological and biochemical parameters for tibia fracture repair in bovines

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Abstract
The study was carried to compare the effect of two surgical techniques on physiological and biochemical parameters before and after fracture repair of tibial bone in bovines. The animals were divide into two groups with six animals in each group. One group Animal's with tibia fracture were operated using Steinmann pin as implant and another group, animals were operated with intramedullary interlocking nail. The physiological *viz*. heart rate, respiratory rate and rectal temperature and biochemical parameters like serum calcium, phosphorous and alkaline phosphatase were assessed at regular intervals of fracture healing. Biochemical and physiological parameters alone were insubstantial in the assessment of fracture healing and should be correlated clinically and radiologically for an all-encompassing, accurate Evaluation of fracture healing.

Keywords: tibia, Steinmann pin, IILN, heart rate, respiratory rate, rectal temperature

1. Introduction
The most severe and challenging pathologies continues to be animal fractures for the veterinarian. Experimental and clinical research has been done on long bone fractures and their treatment in order to assess current methods and create fresh ones. The fundamental components of a successful fracture repair are adequate reduction and rigid fracture fixation. In large and small ruminant operations, fractures are frequently found, and managing them in the field can be challenging. Cattle are ideal Orthopaedics patients as they have exceptional bone healing capabilities, most can tolerate limb immobilisation and they rarely experience problems with their contralateral limbs (Mulon, 2013) [4] A fracture is the cessation of bony continuity with or without fragment displacement and is characterised by variable degrees of soft tissue injury, blood vessel rupture, and bruises. In addition to the symptoms of the fracture, internal organ injury and lacerated skin might also occur.
Bovines presented to Veterinary Clinical Complex, Veterinary College, Bidar with the history and clinical signs depicting tibial fracture were used for study after detailed physical, orthopaedic and radiographic examination. Of the animals screened, twelve animals with tibia fracture, based on the type of fracture and the method used for repair, six animals were chosen and separated into two groups, each with no other concurrent illnesses.

2. Materials and methods
2.1 Selection of animals and design of study
Bovines presented to Veterinary Clinical Complex, Veterinary College, Bidar with the history and clinical signs of tibial fracture were used for study after detailed physical, Orthopaedics and radiographic examination. Of the animals screened, twelve animals with tibial fracture, based on the type of fracture and the method used for repair, six animals were chosen and separated into two groups, each with no other concurrent illnesses.

Group I: This group consisted of 6 bovines with diaphyseal or metaphyseal tibial fracture. The animals of this group were subjected to fracture repair using Steinmann pin.

Group II: This group consisted of 6 bovines with diaphyseal or metaphyseal tibial fracture. The animals of this group were subjected to fracture repair using intramedullary interlocking nail.

Table 1: Design of technical programme of clinical study

Sl. No	Groups	Animals	Bone involved and fracture type	Implant type	Anaesthetic combination
1	I (Bovine)	6	Tibia,diaphyseal/ metaphyseal	Steinmann Pin	Induction: Guaifenesin (50 mg/Kg, iv, 5% solution) After 5 minutes (Tiletamine + Zolazepam) 3 mg/Kg iv Maintenance: Isoflurane (1-2%)
2	II (Bovine)	6	Tibia,diaphyseal/ metaphyseal	Intramedullary Interlocking nail	

In both groups, whole blood was collected and physiological parameters were recorded pre-operatively and post-operatively on the 0th, 30th, 45th and 60th day. The whole blood was collected aseptically from the jugular vein of bovines in clot activator vacutainers and serum was separated. Calcium (mg/dL), phosphorus (mg/dL) and alkaline phosphatase (IU/L) was estimated on a semi-automated clinical chemistry analyser. Heart rate (beats/minute) was estimated by auscultation with a stethoscope, respiratory rate (breaths/minute) was noted by observation of the chest movement and rectal temperature (°F) was recorded by placing a clinical thermometer in the rectum of the dogs in both groups. The data obtained was tabulated and statistically Analysed using student's t-test.

3. Results and Discussion

3.1 Physiological parameters

In all groups of animals, physiological measurements such as heart rate, respiration rate and rectal temperature were taken prior to surgery, immediately following surgery, and on the 30th, 45th, and 60th post-operative days.

3.1.1 Heart rate (beats/minute)

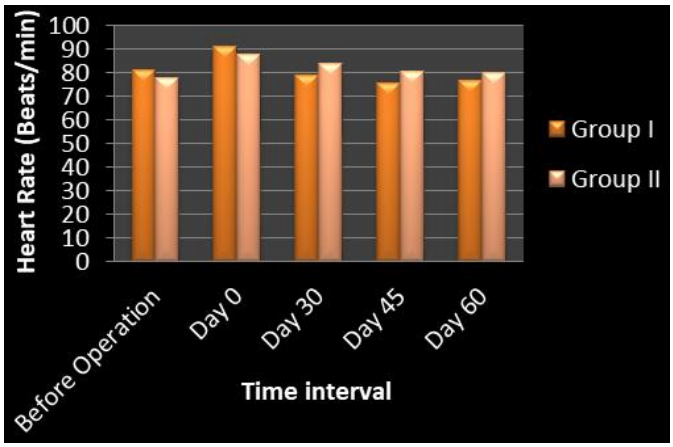

Fig 1: Heart Rate

Table 2: Mean ± SE values of Heart rate (beats/ minute) before and after treatment in group I and II animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	81.5±2.85	91.83^{**a} ±1.34	79±2.62	75.67^{a} ±2.02	76.67±2.84
2	Group II	77.83±2.54	88. 16^{**b} ±0.49	83.83*±1.36	80.5^{b} ±1.56	80.33±2.10

** Means bearing superscript ** differ significantly ($p \leq 0.01$) from 0 day within the group

^{a,b},Means bearing different superscripts differ significantly ($p \leq 0.05$) between groups at corresponding intervals of group I and II animals

In animals of all the groups, heart rate was decreased on post-operative days when compared to before operation except on day 0 in all groups. There was statistically significant increase in heart rate immediately after operation ($p \leq 0.01$) in group I and in group II when compared to heart rate prior to operation. A significant decrease in heart rate ($p \leq 0.05$) was observed in group II bovines in comparison to group I bovines However the decrease was within the normal physiological limit. On comparison between groups I and II there was no significant difference ($p \leq 0.05$) on 30th, 45th, and 60th post-operative days. The heart rate between different post-operative days fluctuated within the normal physiological limits.

3.1.2 Respiratory rate (breaths/minute)

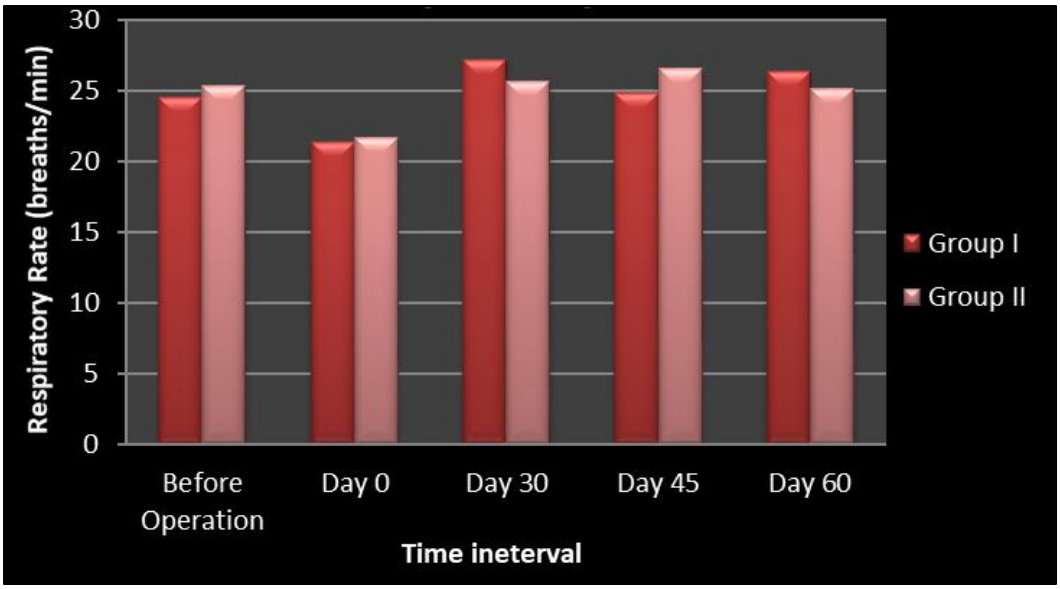

Fig 2: Respiratory Rate

Table 3: Mean ± SE values of Respiratory Rate (breaths/min) before and after treatment in groups I and II animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	24.5±0.69	21.33*±0.96	27.17**±0.55	24.83±0.95	26.33±0.80
2	Group II	25.33±0.30	21.67**±0.51	25.67±0.56	26.5±0.69	25.16±0.49

* Means bearing superscript * differ significantly ($p \leq 0.05$) from 0 day within the group.
** Means bearing superscript ** differ significantly ($p \leq 0.01$) from 0 day within the group

On comparing data of respiratory rate there was significant decrease ($p \leq 0.05$) in group I on day 0 and significant increase ($p \leq 0.01$) at day 30 when compared to before operation respiratory rates. In group II there was significant decrease ($p > 0.01$) on day 0 in comparison to before operation respiratory rate. In both the groups there was statistically significant decrease in respiratory rates when compared with those rates prior to operation. However all the fluctuations in respiratory rates were within normal physiological limit.

3.1.3 Rectal temperature (ºF)

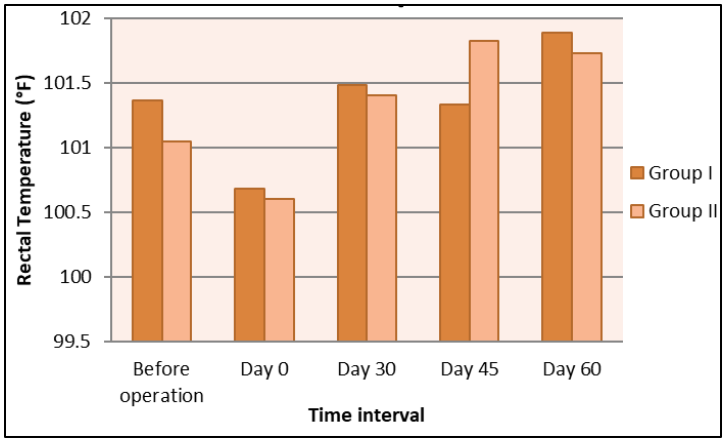

Fig 3: Rectal Temperature

Table 4: Mean ± SE values of Rectal Temperature before and after treatment in different groups of animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	101.36±0.20	100.68*±0.15	101.48±0.18	101.33 a ±0.21	101.89*±0.06
2	Group II	101.05±0.22	100.6±0.24	101.4±0.17	101.82*b ±0.14	101.73*±0.14

* Means bearing superscript * differ significantly ($p \leq 0.05$) from 0 day within the group.
a,b, Means bearing different superscripts differ significantly ($p \leq 0.05$) between groups at corresponding intervals of group I and II animals

In group I significant decrease ($p \leq 0.05$) was noticed on day 0. In group I and II statistically significant increase ($p \leq 0.05$) was noticed on day 60. Rectal temperature showed significant difference ($p \leq 0.05$) between groups I and II at day 45. All the rectal temperature fluctuations were within normal physiological limit.

3.2 Biochemical parameters
3.2.1 Serum Calcium (mg/dL)

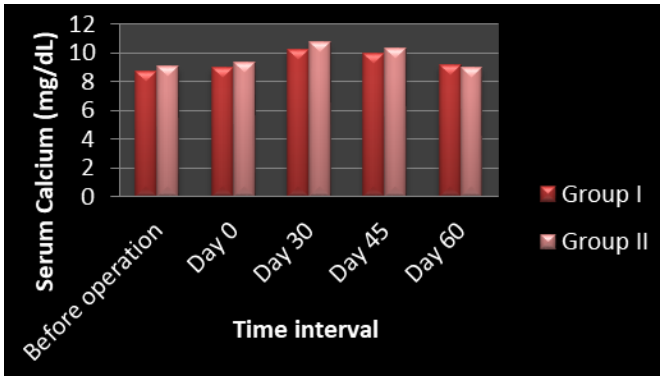

Fig 4: Serum calcium

Table 5: Mean ± SE values of Serum Calcium (mg/dL) before and after treatment in different groups of animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	8.73±0.25	8.96±0.35	10.28**±0.35	9.98**±0.31	9.15±0.29
2	Group II	9.08±0.23	9.33±0.26	10.73**±0.30	10.31**±0.27	9.01±0.22

** Means bearing superscript ** differ significantly ($p \leq 0.01$) from 0 day within the group

In group I and II there was statistically significant difference ($p \leq 0.01$) with increase in serum calcium values at day 30 and day 45 when compared with values before operation.

In both the group of animals serum calcium values increased significantly at day 30 and continued to till 45th day and started to decrease by upto day 60 of study period non-significantly. The fluctuations of the serum calcium values were within the normal physiological limit in all the animals of both groups.

The comparison between the groups showed non-significant fluctuation at different intervals of study period. These findings are in agreement with the earlier workers *viz.*, Lauren and Kelly (1969) [3], Pandey and Udapa (1981) [5] and Vasantha (1991) [12]. The serum calcium level and fracture healing could not be correlated in the study, which confirmed the findings of earlier workers Singh *et al.* (1976) [8].

3.2.2 Serum Phosphorous (mg/dL)

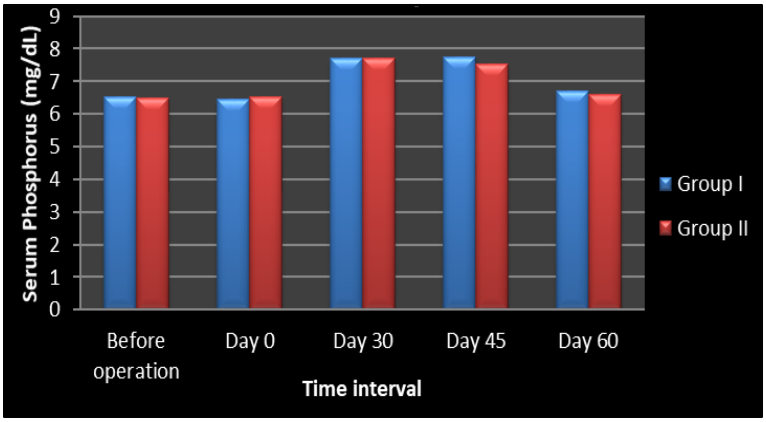

Fig 5: Serum Phosphorus

Table 6: Mean ± SE values of Serum Phosphorus (mg/dL) before and after treatment in group I and II animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	6.51±0.12	6.45±0.13	7.71**±0.13	7.76**±0.11	6.71±0.26
2	Group II	6.48±0.18	6.53±0.19	7.72**±0.12	7.55**±0.15	6.61±0.12

** Means bearing superscript ** differ significantly ($p \leq 0.01$) from 0 day within the group

In comparative study of serum phosphorous data in group I and II, on day 30 and day 45 values were significantly increased ($p \leq 0.01$) when compared to values before operation. Between the groups I and II showed non-significant fluctuations of the values at different intervals of study period. The results are in agreement with the findings of Pandey and Udapa (1981) [5], and different from findings of Soliman and Hassan (1964) [10], Vasantha (1991) [12] and Prachasilpchai *et al.* (2003), who observed a non-significant change in serum phosphorus level during fracture healing

3.2.3 Serum Alkaline Phosphatase

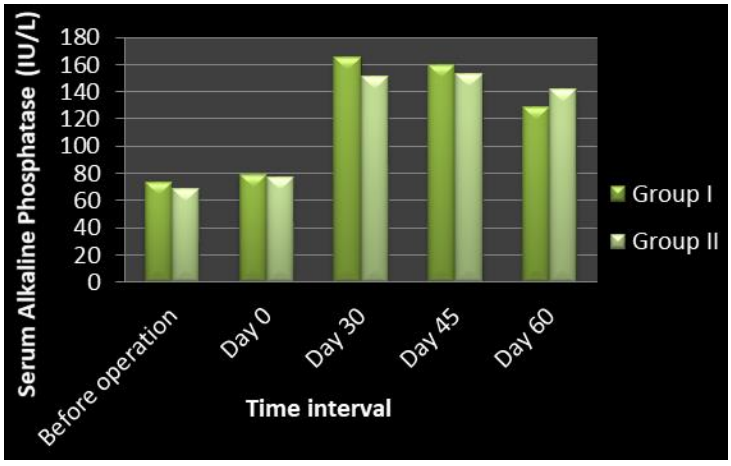

Fig 6: Serum Alkaline Phosphatase

Table 7: Mean ± SE values of Serum Alkaline Phosphatase (IU/L) before and after treatment in group I and II of animals

Sl. No	Groups	Before Operation	Day 0	Day 30	Day 45	Day 60
1	Group I	73.83±6.44	79.33±7.88	165.83^{**a} ±5.37	159.66** ±3.85	129^{**a} ±5.84
2	Group II	68.66±1.61	77.33*±3.54	151.83^{**b} ±4.95	153.33** ±0.83	142.33^{**b} ±1.28

* Means bearing superscript * differ significantly ($p \leq 0.05$) from 0 day within the group.
** Means bearing superscript ** differ significantly ($p \leq 0.01$) from 0 day within the group
a, b, Means bearing different superscripts differ significantly ($p \leq 0.05$) between groups at corresponding intervals of group I and II animals

In the present study serum alkaline phosphatase values of group I and group II showed significant increase ($p \leq 0.01$) at day 30, day 45 and at day 60 from the pre-operative values. The increase in the values at day 30 and 45 were above the normal physiological limit. Between the group I and II the values showed significant difference ($p \leq 0.05$) at day 30 and day 60.

The significant increase in the enzyme level may be attributed to proliferation of osteogenic cells in the early stages of fracture repair (Pritchard, 1952) [7]. Similarly Hunsberger and Ferguson (1932) [1] noticed an increase in serum alkaline phosphatase level during early period of fracture repair. Kumar *et al*. (1999) [2] evaluated biochemical changes in fracture repair in calves and observed a higher level of serum alkaline phosphatase from 15 to 80 days of fracture healing

4. Conclusions

The physiological and biochemical parameters fluctuated within normal limits and no significant alterations were noticed. The serum alkaline phosphatase fluctuated above normal physiological limit during study period on day 30 and 45 however by day 60 it was within normal physiological limit. The physiological findings and biochemical parameters were of little value in assessing the fracture healing. For a comprehensive, precise evaluation of fracture healing, they should be coupled clinically and radio logically.

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